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PATENT APPLICATION
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AMENDMENTS TO THE CLAIMS

Please amend the claims as set forth below. Please cancel Claims 3 and 17 without prejudice. Claim 20 is newly added.

1. (Currently Amended) A transmitter for transmitting complex symbols in a wireless communication system, comprising:

three transmission antennas; and

an encoder ~~for~~ ensuring maximum diversity by grouping N input symbols into N combinations each including three symbols by applying negative and conjugate to the symbols so that the N input symbols are transmitted only once from each antenna and at each time interval, and delivering the N combinations to the three transmission antennas for N time intervals;

wherein at least two symbols selected from the N input symbols are phase-rotated by predetermined phase values.

2. The transmitter of claim 1, wherein N is 4.

3. (Cancelled)

4. (Currently Amended) The transmitter of claim ~~3~~2, wherein for quadrature phase shift keying (QPSK), the phase values range from 21° to 69°, centering on 45°.

5. (Currently Amended) The transmitter of claim ~~3~~2, wherein for 8-ary phase shift keying (8PSK), the phase values range from 21° to 24°.

6. (Currently Amended) The transmitter of claim ~~3~~2, wherein for 16-ary phase shift keying (16PSK), the phase values are 11.25°.

7. (Original) The transmitter of claim 2, wherein the encoder produces four combinations by applying negative and conjugate to four symbols so that two symbol sequences among three symbol sequences delivered to each antenna for four time intervals are orthogonal with each other.

8. (Original) The transmitter of claim 7, wherein the four combinations are each comprised of the four input symbols and constitute matrixes each having four rows and three columns, as follows

$$\begin{bmatrix} x_1 & x_2 & -x_3^* \\ -x_2^* & x_1^* & x_4 \\ x_3 & x_4 & x_1^* \\ -x_4^* & x_3^* & -x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & -x_3^* \\ -x_2^* & x_1^* & -x_4 \\ x_3 & x_4 & x_1^* \\ -x_4^* & x_3^* & x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & x_3^* \\ -x_2^* & x_1^* & x_4 \\ x_3 & x_4 & -x_1^* \\ -x_4^* & x_3^* & -x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & x_3^* \\ -x_2^* & x_1^* & -x_4 \\ x_3 & x_4 & -x_1^* \\ -x_4^* & x_3^* & x_2 \end{bmatrix}$$

$$\begin{bmatrix} x_1 & x_2 & -x_3^* \\ -x_2^* & x_1^* & x_4 \\ x_3 & x_4 & x_1^* \\ x_4^* & -x_3^* & x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & x_3^* \\ -x_2^* & x_1^* & x_4 \\ x_3 & x_4 & -x_1^* \\ x_4^* & -x_3^* & x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & -x_3^* \\ x_2^* & -x_1^* & x_4 \\ x_3 & x_4 & x_1^* \\ -x_4^* & x_3^* & x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & x_3^* \\ x_2^* & -x_1^* & x_4 \\ x_3 & x_4 & -x_1^* \\ -x_4^* & x_3^* & x_2 \end{bmatrix}$$

$$\begin{bmatrix} x_1 & x_2 & -x_3^* \\ x_2^* & -x_1^* & -x_4 \\ x_3 & x_4 & x_1^* \\ x_4^* & -x_3^* & x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & -x_3^* \\ x_2^* & -x_1^* & x_4 \\ x_3 & x_4 & x_1^* \\ x_4^* & -x_3^* & -x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & x_3^* \\ x_2^* & -x_1^* & -x_4 \\ x_3 & x_4 & -x_1^* \\ x_4^* & -x_3^* & x_2 \end{bmatrix}\begin{bmatrix} x_1 & x_2 & x_3^* \\ x_2^* & -x_1^* & x_4 \\ x_3 & x_4 & -x_1^* \\ x_4^* & -x_3^* & -x_2 \end{bmatrix}$$

where x_1, x_2, x_3 and x_4 are four input symbols including two phase-rotated symbols.

9. (Original) The transmitter of claim 1, wherein N is 3.

10. (Original) The transmitter of claim 9, wherein three combinations are each comprised of three input symbols and constitute a matrix having three rows and three columns, as follows

$$\begin{bmatrix} e^{-j\theta_1}s_1 & e^{-j\theta_2}s_2 & s_3 \\ s_3 & e^{-j\theta_1}s_1 & e^{-j\theta_2}s_2 \\ e^{-j\theta_2}s_2 & s_3 & e^{-j\theta_1}s_1 \end{bmatrix}$$

where s_1, s_2 and s_3 are the three input symbols, and θ_1 and θ_2 are phase values of s_1 and s_2, respectively.

11. (Original) The transmitter of claim 9, wherein the phase values are a multiple of 30°, and are determined so that a difference between the phase values becomes maximized.

Claims 1-2
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12. (Currently Amended) A receiver for receiving complex symbols in a wireless communication system, comprising:

a symbol arranger for receiving signals received via at least one reception antenna from three transmission antennas, for four time intervals, the symbol arranger forming a matrix by collecting the signals received via the at least one reception antenna, where signals received via one reception antenna are arranged in one row, and signals received via another reception antenna are arranged in another row;

a channel estimator for receiving signals via the at least one reception antenna, and estimating three channel gains representing channel gains from the three transmission antennas to the at least one reception antenna;

first and second decoders for calculating metric values for all possible sub-combinations each including two symbols by using the channel gains received from the channel estimator and the signals received by the symbol arranger, and detecting two symbols having a minimum metric value; and

a parallel-to-serial converter for sequentially arranging two symbols detected by the first and second decoders.

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13. (Original) The receiver of claim 12, wherein the first and second decoders each comprise:

a symbol generator for generating all possible sub-combinations each including two symbols;

a phase rotator for phase-rotating one symbol selected from the two symbols by a predetermined phase value;

a metric calculator for calculating a metric value for symbol sub-combinations including the phase-rotated symbol with the signals received by the symbol arranger and the channel gains; and

a detector for detecting two symbols having a minimum metric value by using the calculated metric values.

14. (Original) The receiver of claim 13, wherein the first decoder detects two symbols for minimizing a metric value calculated by

$$|R_1-e^{j\theta_1}s_1|^2+|R_3-s_3|^2+2(C_3)Re\{e^{-j\theta_1}s_1^*s_3\}$$

where s_1 and s_3 are two symbols to be detected, θ_1 is a phase value of s_1, $R_1=r_1h_1^*+r_2^*h_2+r_3^*h_3$, $R_3=r_2^*h_3+r_4h_1^*-r_3^*h_2$, $C_3=h_3^*h_2-h_3h_2^*$, h_1, h_2 and h_3 are channel gains estimated for three transmission antennas, and r_1, r_2, r_3 and r_4 are signals received for four time intervals.

15. (Original) The receiver of claim 13, wherein the second decoder detects two symbols for minimizing a metric value calculated by

$$|R_2-e^{j\theta_2}s_2|^2+|R_4-s_4|^2+2(C_4)Re\{e^{-j\theta_2}s_2^*s_4\}$$

where s_2 and s_4 are two symbols to be detected, θ_2 is a phase value of s_2, $R_2=r_1h_2^*-r_2^*h_1+r_4h_3^*$, $R_4=r_1h_3^*-r_3^*h_1-r_4h_2^*$, $C_4=h_3h_2^*-h_3^*h_2$, h_1, h_2 and h_3 are channel gains estimated for three transmission antennas, and r_1, r_2, r_3 and r_4 are signals received for four time intervals.

16. (Currently Amended) A receiver for receiving complex symbols in a wireless communication system, comprising:

a symbol arranger for receiving signals received via at least one reception antenna from three transmission antennas, for three time intervals, the symbol arranger forming a matrix by collecting the signals received via the at least one reception antenna, where signals received via one reception antenna are arranged in one row, and signals received via another reception antenna are arranged in another row;

a channel estimator for receiving signals via the at least one reception antenna, and estimating three channel gains representing channel gains from the three transmission antennas to the at least one reception antenna; and

a decoder for calculating metric values for all possible symbol combinations each including three symbols by using the channel gains received from the chanel estimator and the signals received by the symbol arranger, and detecting three symbols having a minimum metric value comprising:

a symbol generator for generating all possible symbol combinations each including three symbols;

two phase rotators for phase-rotating two symbols selected from the three symbols by predetermined phase values (Θ_1, Θ_2);

a metric calculator for calculating metric values for symbol combinations including the phase-rotated symbols with the signals received by the symbol arranger and the channel gains; and

a detector for detecting three symbols having a minimum metric value by using the calculated metric value.

17. (Cancelled)

18. (Currently Amended) The receiver of claim ~~17~~16, wherein the decoder detects three symbols for minimizing a metric value calculated by

$$\left|r_1-h_1e^{-j\theta_1}s_1-h_2e^{-j\theta_2}s_2-h_3s_3\right|^2+\left|r_2-h_1s_3-h_2e^{-j\theta_1}s_1-h_3e^{-j\theta_2}s_2\right|^2 +\left|r_3-h_1e^{-j\theta_2}s_2-h_2s_3-h_3e^{-j\theta_1}s_1\right|^2$$

$$\left|r_1-h_1e^{-j\theta_1}s_1-h_2e^{-j\theta_2}s_2-h_3s_3\right|^2+\left|r_2-h_1s_3-h_2e^{-j\theta_1}s_1-h_3e^{-j\theta_2}s_2\right|^2 +\left|r_3-h_1e^{-j\theta_2}s_2-h_2s_3-h_3e^{-j\theta_1}s_1\right|^2$$

where s_1, s_2 and s_3 are three symbols constituting a symbol combination, θ_1 and θ_2 are phase values of s_1 and s_2, respectively, h_1, h_2 and h_3 are channel gains for three transmission antennas, and r_1, r_2 and r_3 are signals received for three time intervals.

19. (Currently Amended) A transmitter for transmitting complex symbols in a wireless communication system, comprising:

M transmission antennas; and

an encoder ~~for~~ ensuring maximum diversity by grouping N input symbols into N combinations each including M symbols by applying negative and conjugate to the symbols so that the N input symbols are transmitted only once from each antenna and at each time interval, and delivering the N combinations to the M transmission antennas for N time intervals;

wherein at least two symbols selected from the N input symbols are phase-rotated by predetermined phase values.

20. (New) The transmitter according to claim 9, wherein the encoder produces three combinations by applying negative and conjugate to three symbols (s_1, s_2, s_3) so that two symbol sequences among three symbol sequences delivered to each antenna for three time intervals are orthogonal with each other.